DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

Author/requestor: **Jared Johnson, Phius Alliance Minnesota**

Marcy Conrad Nutt, Passive House Minnesota

Email address:

Telephone number:

Date: **August 29, 2023**

Model Code: **2021 IECC**

Code or Rule Section: **R402.4.1.3**

Firm/Association affiliation, if any: **Phius Alliance Minnesota, Passive House Minnesota**

Code or rule section to be changed: **R402.4.1.3 Leakage Rate**

Intended for Technical Advisory Group ("TAG"):

General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☒	☐
B. Is the proposed change required due to climatic conditions of Minnesota?	☒	☐
C. Will the proposed change encourage more uniform enforcement?	☒	☐
D. Will the proposed change remedy a problem?	☒	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☐	☒
F. Would this proposed change be appropriate through the ICC code development process?	☐	☒

Proposed Language

1. The proposed code change is meant to:

☒ change language contained the model code book? If so, list section(s).

R402.4.1.3 Leakage Rate

☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

☐ delete language contained in the model code book? If so, list section(s).

☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

☐ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

   No

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

   R402.4.1.3 Leakage Rate
   "When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 0, 1 and 2, and ~~3.0~~ 2.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2."

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.

   No

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)

   Tighter air sealing:
   Air leakage in cold climates creates unnecessary costs for property owners, as well as health and durability challenges in our Minnesota climate:

   - **In winter, leaks carry warm, moist air through building walls, causing condensation within the wall cavity. This, in turn, creates rot and mold, which lead to unnecessary health risks and maintenance costs. In addition, heating dollars and humidity are lost through the leaks.**

   - **In summer, air leakage results in lost cooling dollars. Leaks also let in allergens, increasingly common pollutants such as wildfire smoke, and humidity. Keeping humidity levels at a safe and healthy level is easier and cheaper in buildings that are well air-sealed.**

   Lowering the requirement from 3.0 ACH50 to 2.0 would provide better protection against the issues listed above and improve overall energy performance, while still remaining achievable with current construction materials and practices.

2. Why is the proposed code change a reasonable solution?

   Air-sealing uses materials and methods already common and affordable within the building industry. We believe the proposed change can be achieved with little more than education and attention to detail. According to RESNET: Of the 6,143 completed HERS-rated projects in Minnesota over the last 12 months, 75% of those projects have achieved an ACH level of 2.0 or lower.

3. What other factors should the TAG consider?

   Tighter air sealing has definite benefits, but requires balanced ventilation to maintain a healthy interior environment – the two must be considered together.

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.

   As stated above, we anticipate any cost increase would be minimal. Air sealing is already standard practice, and the majority of new builds in Minnesota are already hitting these ACH levels.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

   The energy savings alone would quickly make up for the minimal extra cost. Extra insurance against moisture intrusion into walls is also a potential offset.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

   Builders, who will pass it along to individual homeowners.

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.

   No, there should not be extra compliance costs.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.

   Not that we are aware of.

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?

   Trade workers (siders, framers, specialized subcontractors)

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the alternatives are and why your proposed change is the preferred method or means to achieve the desired result.

   People might argue against the idea of making air-tight walls, instead choosing to "let the walls breathe". There is an argument to be had in letting walls breathe, as it prevents moisture from sticking around for too long in any cavity. The problem with this approach in our Minnesota climate is that it prevents insulation from ever being used effectively. If we are

going to try to cut down energy usage in cold climates, insulation will have to be part of that solution, and protecting these insulated walls with tight air-sealing is a must.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?

   Over the long term, the amount of energy savings that will not be realized will be tremendous. Small incremental gains can create huge progress when multiplied over thousands and thousands of new homes. More homes will have wall moisture issues as well, which are expensive remediations in comparison to a little extra front-end air sealing work.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.

   We are unaware of any federal or state regulation or requirement related to this proposed change.

***Note: Incomplete forms may be returned to the submitter with instruction to complete the form. Only completed forms can considered by the TAG.

DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

Author/requestor: **Jared Johnson, Phius Alliance Minnesota**

Marcy Conrad Nutt, Passive House Minnesota

Email address:

Telephone number:

Date: **August 29, 2023**

Model Code: **2021 IECC**

Code or Rule Section: **Table R402.1.3**

Firm/Association affiliation, if any: **Phius Alliance Minnesota, Passive House Minnesota**

Code or rule section to be changed: **Table R402.1.3**

Intended for Technical Advisory Group ("TAG"):

General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☒	☐
B. Is the proposed change required due to climatic conditions of Minnesota?	☒	☐
C. Will the proposed change encourage more uniform enforcement?	☐	☒
D. Will the proposed change remedy a problem?	☒	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☐	☒
F. Would this proposed change be appropriate through the ICC code development process?	☐	☒

Proposed Language

1. The proposed code change is meant to:

☒ change language contained the model code book? If so, list section(s).

Table R402.1.3 Insulation Minimum R-Values and Fenestration Requirements by Component
(Dec. 2020 version)

☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

☐ delete language contained in the model code book? If so, list section(s).

☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

☐ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

   No

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

   Table R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT (Dec. 2020 version)

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE
6	**0.30**	**0.55**	**NR**	**60**	***20+~~5ci~~ 10ci or 0+20ci***	**15/20**	**30**
7 and 8	**0.30**	**0.55**	**NR**	**60**	***20+~~5ci~~ 14ci or 0+20ci***	**19/21**	**38**

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.

   No

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)

   In the Residential Chapter of the 2021 International Energy Conservation Code, the wall insulation requirement in Table R402.1.3 (for both Climate Zone 6 & 7) includes the option to use R20 + 5ci. R20 + 5ci is an insulation assembly that specifies R-20 for cavity insulation along with R-5 for exterior continuous insulation. This will likely pose moisture problems in Minnesota's climate zones.

2. Why is the proposed code change a reasonable solution?

   According to the study by the Building Science Corporation, BSD-163: Controlling Cold-Weather Condensation Using Insulation by John Straube, the exterior insulation R-value should be roughly 50% of the cavity insulation in Climate Zone 6. In the case of R20 + 10ci, the ratio of continuous to exterior insulation is 0.5 (10/20). In this case, there would be insufficient exterior insulation to protect against cold-weather condensation in the walls. By utilizing continuous insulation with a minimum R-value of 10, the optimal 50% cavity-to-continuous insulation ratio is achieved.

   In Climate Zone 7, the recommended ratio increases - the exterior insulation R-value should be approximately 70% of the cavity insulation due to colder winter temperatures. This results in a recommended continuous insulation R-value of 14 when utilizing R20 insulation within the cavity. (14/20 = 0.7)

3. What other factors should the TAG consider?

The additional exterior insulation would also generate substantial benefits to homeowners in added energy savings and thermal comfort.

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.

   Adding additional exterior insulation will slightly raise the cost. The difference between 1" of exterior insulation (R-5) and 2" (R-10) is about $19 per board (which is equivalent to 32 square feet). For a typical home, with roughly 1,800 square feet of wall area, the additional cost is about $1,050 per home.

   The difference between 1" of exterior insulation (R-5) and 3" (R-14) is about $40 per board. Under the same assumption, the typical cost increase would equal approximately $2,250 per home.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

   This cost must be weighed against both the additional energy savings as well as the saved cost from avoiding condensation within the wall cavity. The repair costs due to moisture problems in walls alone would strongly outweigh any additional cost.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

   Individuals would bear the cost increase.

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.

   There is no direct change in enforcement nor compliance costs with this proposal. Aligning the code with current building science recommendations could result in reduced litigation costs.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.

   Not that we are aware of.

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?

   Home buyers / renters, builders, trades, owners, manufacturers, architects

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the

alternatives are and why your proposed change is the preferred method or means to achieve the desired result.

Hygrothermal modeling of wall assemblies to determine condensation risk could be an option, but that would come with enforcement/compliance costs.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?

   Homeowners will have to deal with wall insulation condensation issues and the associated costs of remedying those issues. Government entities may have to deal with legal challenges.

   The added energy savings of having a higher R-value wall will also bolster the cost-benefit outlook for this change. For the trades that install the CI, this is not a big shift in the practice from the baseline IECC 2021 code- it is simply installing a thicker board.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.

   We are unaware of any federal or state regulation or requirement related to this proposed change.

***Note: Incomplete forms may be returned to the submitter with instruction to complete the form. Only completed forms can considered by the TAG.

DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

Author/requestor: Ben Rabe

Date:

Email address:

Telephone number:

Model Code: 2012 IECC

Code or Rule Section: Residential Energy Code

Firm/Association affiliation, if any: New Buildings Institute

Code or rule section to be changed: R402.1

Intended for Technical Advisory Group ("TAG"):

General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☐	☒
B. Is the proposed change required due to climatic conditions of Minnesota?	☐	☒
C. Will the proposed change encourage more uniform enforcement?	☒	☐
D. Will the proposed change remedy a problem?	☐	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☒	☒
F. Would this proposed change be appropriate through the ICC code development process?	☒	☐

Proposed Language

1. The proposed code change is meant to:

   ☐ change language contained the model code book? If so, list section(s).

   ☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

   ☐ delete language contained in the model code book? If so, list section(s).

   ☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

   ☒ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

   No.

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

Revise as follows: (Portions of table not shown remain unchanged.)

TABLE R402.1.2 (TABLE N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT*U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]
~~1~~	~~NR~~	~~0.75~~	~~0.25~~
~~2~~	~~0.40~~	~~0.65~~	~~0.25~~
~~3~~	~~0.32~~	~~0.55~~	~~0.25~~
~~4 except Marine~~	~~0.32~~	~~0.55~~	~~0.40~~
~~5 and Marine 4~~	~~0.30~~	~~0.55~~	~~NR~~
6	~~0.30~~ 0.28	~~0.55~~ 0.50	NR
7 ~~and 8~~	~~0.30~~ 0.27	~~0.55~~ 0.50	NR

For SI: 1 foot = 304.8 mm.

a. Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.
b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall U-factors shall not exceed 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.
c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall U-factor shall not exceed 0.360.
d. The fenestration U -factor column excludes skylights. The SHGC column applies to all glazed fenestration.
Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the
~~e. There are no SHGC requirements in the Marine Zone.~~
~~f~~. e. A maximum U-factor of ~~0.32~~ 0.30 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings
1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the International Residential Code.

Revise as follows: (Portions of table not shown remain unchanged.)

TABLE R402.1.3 (TABLE N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BYCOMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT*U*-FACTOR[b]	GLAZED FENESTRATION SHGC[b, ~~e~~]
~~1~~	~~NR~~	~~0.75~~	~~0.25~~
~~2~~	~~NR~~	~~0.75~~	~~0.25~~
~~3~~	~~0.40~~	~~0.65~~	~~0.25~~

~~4 except Marine~~	~~0.30~~	~~0.55~~	~~0.40~~
~~5 and Marine 4~~	~~0.30~~[i]	~~0.55~~	~~0.40~~
6	~~0.30~~ 0.28[i]	~~0.55~~ 0.50	NR
7 ~~and 8~~	~~0.30~~ 0.27 [i]	~~0.55~~ 0.50	NR

For SI: 1 foot = 304.8 mm.
NR = Not Required.
ci = continuous insulation.

a.*R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.
b.The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed ~~0.30~~ 0.28.
c."5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13&5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.
d.R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab-edge insulation for heated slabs shall not be required to extend below the slab.
e.There are no SHGC requirements in the Marine Zone.
f.Basement wall insulation is not required in Warm Humid locations as defined by Figure R301.1 and Table R301.1.

g.The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13&5" means R-13 cavity insulation plus R-5 continuous insulation.
h.Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.
i.A maximum *U*-factor of ~~0.32~~ 0.30 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. 1.Above 4,000 feet in elevation, or
2. 2.In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.

   No.

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)

   This proposed change to the fenestration U-factor aligns the IECC with the ENERGY STAR Version 6.0 specification. The ENERGY STAR specification for windows in climate zones 5-8 has been in place since January 1, 2016. Products that meet the ENERGY STAR standard are widely available and have been for some time. In 2016 – the first year the ENERGY STAR Version 6.0 specification was in effect for all climate zones – ENERGY STAR windows already had an 83% market share.

   Replacing old windows with ENERGY STAR certified windows lowers household energy bills by an average of 12 percent nationwide. The Environmental Protection Agency performed a cost-effectiveness analysis of Version 6.0 and found it to be cost-effective. That analysis can be found here: http://www.energystar.gov/sites/default/files/ESWDS-ReviewOfCost_EffectivenessAnalysis.pdf EPA notes that manufacturers can meet the proposed specification for climate zones 5-8 using either double- or triple-pane windows. In general, EPA's data show that double-pane windows that meet the northern climate zone specification are cost effective for consumers. Feedback that EPA has received from stakeholders confirms that new glass technologies, improvements in frame performance, and/or better spacer performance can help many product lines meet the proposed Northern Zone criteria with double-pane windows.

2. Why is the proposed code change a reasonable solution?

   The cost of high efficiency window is negligible and saves homeowners in utility costs.

3. What other factors should the TAG consider?

   None

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.

   EPA estimates that the current market share of Energy Star version 6 products is very high: 86% for windows, 80% for hinged entry doors, 84% for patio doors, and 72% for skylights. This demonstrates that fenestration meeting the proposed requirements are ubiquitous and will not increase the cost of construction for the vast majority of homeowners. Nonetheless, for the minority of products that do not meet the Energy Star version 6 criteria, there will be a marginal increase in cost. EPA's analysis in 2012-14 of the change to the version 6 criteria "shows that average-cost products offer payback periods of less than 10 years in all but five cities and payback periods of less than seven years in half of the cities for which EPA performed energy savings analysis", and less for lower cost products. As the industry transitions to the Energy Star version 7 requirements, the cost and payback for these version 6 criteria will be even less. Additionally, there would be no increase in construction cost for locations meeting the altitude or windborne debris provisions in footnote f.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

   If there is any cost increase it will be recouped quickly in energy savings.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

   Homeowner will be passed additional cost of high efficiency windows (if any additional cost).

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.

   None, windows will be inspected as usual.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.

   No.

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?

Window manufacturers and installers.

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the alternatives are and why your proposed change is the preferred method or means to achieve the desired result.

   No.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?

   This proposal will save homeowner in energy costs for a negligible cost increase.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.

   No.

***Note: Incomplete forms may be returned to the submitter with instruction to complete the form. Only completed forms can considered by the TAG.

September 29, 2023

A Case For Windows

To: Residential Energy Code TAG Members

From: The Efficient Technology Accelerator (ETA)

The following information is intended to support the code change proposal to change the maximum assembly U-value for Fenestration in the Residential Energy Code (2021 IECC) from 0.30 to 0.27 for climate zones 6 and 7.

While it may look small, U-0.30 to U-0.27 is a large performance improvement and will have significant impacts on energy bills and comfort.

- To put the performance improvement in context, a window U-value improvement from 0.30 to 0.27 **is equivalent to an attic insulation improvement from R-20 to R50**.
- Windows are the weakest performing aspect of the building envelope. Therefore, this code change would have significant impacts on envelope performance.

U-0.27 windows are widely available in today's market.

- EPA estimated that windows meeting the ENERGY STAR Version 6 specification in the northern zone made up **89% of the market in 2019**. This is only expected to grow by the time the MN Residential Energy Code is implemented[1].
- There are 1,756 certified window products listed in the ENERGY STAR database that meet the northern zone requirements of ENERGY STAR Version 6[2]. This includes 487 wood products and 27 aluminum windows.

Lower U-value does not necessarily mean higher cost.

- The EPA conducted consumer price research during the development of ENERGY STAR Version 7 that found that window prices vary widely, regardless of performance level.
- The following graphic, from an ENERGY STAR Stakeholder meeting presentation, shows that **there are numerous products available meeting the 0.27 performance criteria**; including double pane wood windows and double pane vinyl windows.

---

[1] See ENERGY STAR Stakeholder meeting presentation slide #7

[2] ENERGY STAR Version 6 requires a maximum U-value of 0.27 with SHGC trade-offs

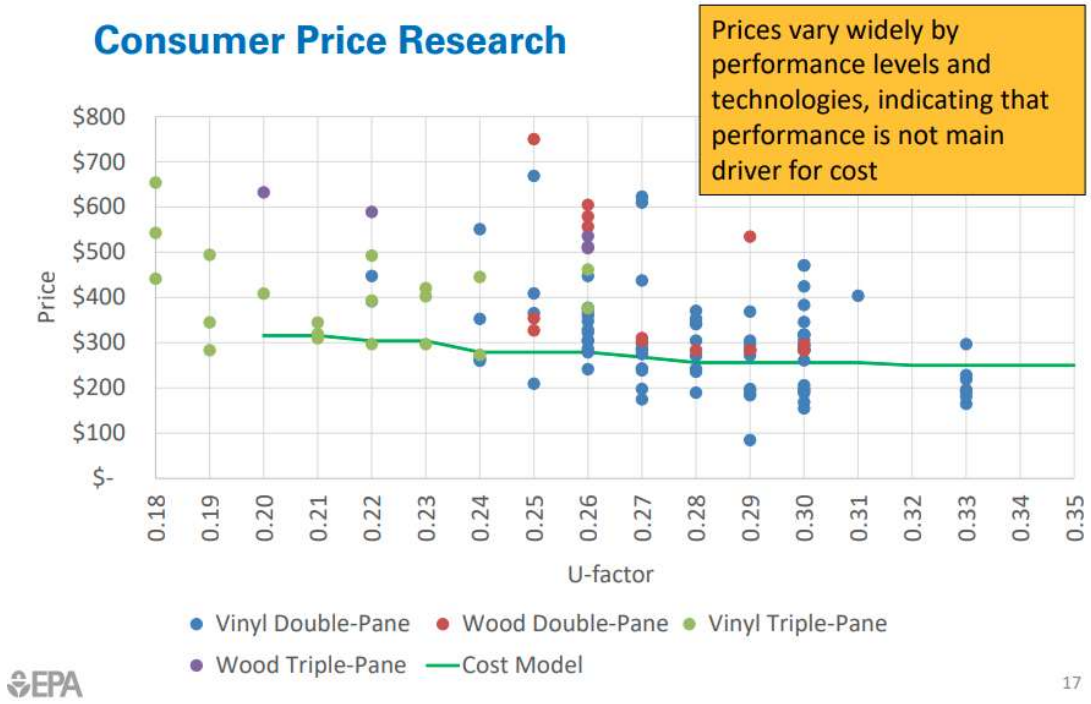

Image Source: ENERGY STAR Stakeholder meeting presentation slide 17.

DEPARTMENT OF LABOR AND INDUSTRY

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

Author/requestor: Steve Shold

Date: 9/8/2023

Email address: steve.shold@state.mn.us

Model Code: 2021 IECC-R

Telephone number:

Code or Rule Section: R402.2.4

Firm/Association affiliation, if any: Dept of Labor & Industry

Code or rule section to be changed: R402.2.4

Intended for Technical Advisory Group ("TAG"):

General Information	**Yes**	**No**
A. Is the proposed change unique to the State of Minnesota?	☐	☒
B. Is the proposed change required due to climatic conditions of Minnesota?	☐	☒
C. Will the proposed change encourage more uniform enforcement?	☒	☐
D. Will the proposed change remedy a problem?	☒	☐
E. Does the proposal delete a current Minnesota Rule, chapter amendment?	☐	☒
F. Would this proposed change be appropriate through the ICC code development process?	☒	☐

Proposed Language

1. The proposed code change is meant to:

   ☐ change language contained the model code book? If so, list section(s).

   ☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

   ☒ delete language contained in the model code book? If so, list section(s).
   R402.2.4 Exception #2.

   ☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

   ☐ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

R402.2.4 Access hatches and doors.
Access hatches and doors from conditioned to unconditioned spaces such as attics and crawl spaces shall be insulated to the same R-value required by Table R402.1.3 for the wall or ceiling in which they are installed.
Exceptions:

1. Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the fenestration requirements of Table R402.1.3 based on the applicable climate zone specified in Chapter 3.
2. ~~Horizontal pull-down, stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces in Climate Zones 0 through 4 shall not be required to comply with the insulation level of the surrounding surfaces provided the hatch meets all of the following:~~
    a. ~~2.1. The average U-factor of the hatch shall be less than or equal to U-0.10 or have an average insulation R-value of R-10 or greater.~~
    b. ~~2.2. Not less than 75 percent of the panel area shall have an insulation R-value of R-13 or greater.~~
    c. ~~2.3. The net area of the framed opening shall be less than or equal to 13.5 square feet (1.25 m2).~~
    d. ~~2.4. The perimeter of the hatch edge shall be weatherstripped.~~

The reduction shall not apply to the total UA alternative in Section R402.1.5.

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.
    No.

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)
    The content in the second exception applies to climate zones 0 through 4 which are not located in Minnesota.

2. Why is the proposed code change a reasonable solution?
    As noted above, it does not have application to Minnesota.

3. What other factors should the TAG consider?
    1. An unlimited quantity of exterior doors and windows complying with the fenestration requirements in Table R402.1.3 can be installed within the thermal envelope.
    2. Section R402.3.4 allows one side-hinged opaque door assembly not greater than 24sf to be exempted from the U-factor requirement in in Section R402.1.2.
    3. Section R402.3.1 permits an area-weighted average of fenestration products to satisfy the U-factor requirements.

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.
   No.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.
   No.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.
   N/A

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.
   No.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed $25,000 for any one small business or small city (Minn. Stat. § 14.127)? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.
   N/A

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?
   Building contractors, designers, municipal building inspectors, and homeowners.

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the alternatives are and why your proposed change is the preferred method or means to achieve the desired result.
   Since the change removes content that would not have had an impact on Minnesota anyway, the only alternate would be to leave the language as written in model code. However, including items that have zero application leads to confusion and complication with application and enforcement.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?
   None.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.
   N/A.

***Note: Incomplete forms may be returned to the submitter with instruction to complete the form. Only completed forms can considered by the TAG.

Minnesota Residential Energy Code
Overall UA Calculations
12-Sep-23 Rev 1-Oct -2023
John G. Smith, P.E.

www.ASHRAE-meteo.info

Code Components Requirements (Simplified):	Weather data	Dec	Jan	Feb	Avg	Coldest Mo.	Avg-10	ASHRAE 99%	99%+15F	Mean Extreme
	MSP	21.8	15.9	20.2	19.3	15.9	9.3	-6	9	-16.8
Zone 6	Duluth	16.9	10.8	14.9	14.2	10.8	4.2	-12.1	2.9	-23.3

	U Factor
Walls:	0.045
Fenestration:	0.30

Allowable to use average winter temperature for the outdoor air temperature for condensation evaluation (per Building Science Corp)

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R5 CI
Wall framing is 2 x 6 for R=6.88 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock	0.45	0.45
Batt insulation	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	5.00	5.00
Siding:	0.16	0.16
Outdoor airfiln	0.17	0.17
R_{total}:	14.12	27.25
U:	0.071	0.037

Temperature - outside surface of component

	Framing	Cavity	
Indoor Temp	72.0	72.0	72F/30% RH is 38.9F dewpoint
	67.6	69.7	72F/20% RH is 29.2F dewpoint
	64.6	68.2	-20F/80% RH is -23.9F dewpoint
	64.6	0.7	Need vapor retarder
	19.8	0.7	
	14.7	-2.0	
	-17.9	-18.9	
	-18.9	-19.4	
	-20.0	-20.0	
Outdoor Tem	-20		

Wall Overall U 0.045

Ratio Exterior-Interior: 0.25
Ratio Ext-Int w/siding: 0.26

Fenestration: U = 0.30

Compare overall U based on percentage of glass
Glass and wall U comply with Table 402.1.2 requirements

				Ug=0.30	Ug=0.27
% Glass	% Framing	% Cavity	Overall Uo	Overall Uo	Overall Uo
15.00%	21.25%	63.75%	0.083	0.083	0.079
20.00%	20.00%	60.00%	0.096	0.096	0.090
25.00%	18.75%	56.25%	0.109	0.109	0.101
30.00%	17.50%	52.50%	0.122	0.122	0.113
35.00%	16.25%	48.75%	0.134	0.134	0.124
40.00%	15.00%	45.00%	0.147	0.147	0.135
45.00%	13.75%	41.25%	0.160	0.160	0.146
50.00%	12.50%	37.50%	0.173	0.173	0.158

From BSD-163: Controlling Cold-Weather Condensation Using Insulation

Table 1: Ratio of exterior-interior insulation to control air leakage condensation

Indoor	RH	--->	20	25	30	35	40	50	60
Dewpoint	°C	--->	-3.0	0.0	2.5	4.7	6.6	9.9	12.7
	°F	--->	26.6	32.0	36.6	40.5	44.0	49.9	54.8
$T_{outdoors}$	°C	°F							
	10	50	0.00	0.00	0.00	0.00	0.00	0.00	0.24
	5	41	0.00	0.00	0.00	0.00	0.10	0.31	0.48
	0	32	0.00	0.00	0.12	0.23	0.32	0.47	0.60
	-5	23	0.08	0.19	0.29	0.37	0.45	0.57	0.68
	-10	14	0.23	0.32	0.40	0.48	0.54	0.64	0.73
	-15	5	0.33	0.42	0.49	0.55	0.60	0.69	0.77
	-20	-4	0.41	0.49	0.55	0.60	0.65	0.73	0.80
	-25	-13	0.48	0.54	0.60	0.65	0.69	0.76	0.82
	-30	-22	0.53	0.59	0.64	0.68	0.72	0.78	0.84

Above values exclude exterior cladding. Adding cladding will decrease percentages.

1994 Minnesota Energy Code required an overall Uo of 0.110 for walls, 0.026 for roofs/ceilings and 0.04 for floors
Allowing designed building to meet UA overall based on components that comply with table 402.1.2
requirements will increase the overall Uo as the percent of fenestration increases which is not

Minnesota Residential Energy Code
Overall UA Calculations
12-Sep-23 Rev 1-Oct -2023
John G. Smith, P.E.

Code Components Requirements (Simplified):

Zone 6

	U Factor
Walls:	0.045
Fenestration:	0.30

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R7.5- CI
Wall framing is 2 x 6 for R=6.88 + R7.5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	7.50	7.50
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	16.62	29.75
U:	0.060	0.034

Wall Overall U_o: 0.040

Fenestration: U = 0.30

www.ASHRAE-meteo.info

Weather data:	Dec	Jan	Feb	Avg	Coldest Mo.	Avg-10	ASHRAE 99%	99%+15F	Mean Extreme
MSP	21.8	15.9	20.2	19.3	20.2	9.3	-21.1	-6.1	-16.8
Duluth	16.9	10.8	14.9	14.2	14.9	4.2	-24.5	-9.5	-23.3

Allowable to use average winter temperature for the outdoor air temperature for condensation evaluation (per Building Science Corp)

Temperature - outside surface of component

	Framing	Cavity	
Indoor Temp	72.0	72.0	72F/30% RH is 38.9F dewpoint
	68.2	69.9	72F/20% RH is 29.2F dewpoint
	65.7	68.5	-20F/80% RH is -23.9F dewpoint
	65.7	6.7	Need vapor retarder
	27.7	6.7	
	23.3	4.2	
	-18.2	-19.0	
	-19.1	-19.5	
Outdoor Temp	-20.0	-20.0	
	-20	-20	

Ratio Exterior-Interior: 0.38
Ratio Ext-Int w/siding: 0.38

Compare overall U based on percentage of glass
Glass and wall U comply with Table 402.1.2 requirements

% Glass	% Framing	% Cavity	Overall Uo
15.00%	21.25%	63.75%	0.079
20.00%	20.00%	60.00%	0.092
25.00%	18.75%	56.25%	0.105
30.00%	17.50%	52.50%	0.118
35.00%	16.25%	48.75%	0.131
40.00%	15.00%	45.00%	0.144
45.00%	13.75%	41.25%	0.157
50.00%	12.50%	37.50%	0.170

1994 Minnesota Energy Code required an overall Uo of 0.110 for walls, 0.026 for roofs/ceilings and 0.04 for floors
Allowing designed building to meet UA overall based on components that comply with table 402.1.2 requirements will increase the overall Uo as the percent of fenestration increases which is not a desired condition.

From BSD-163: Controlling Cold-Weather Condensation Using Insulation

Table 1: Ratio of exterior-interior insulation to control air leakage condensation

Indoor	RH	--->	20	25	30	35	40	50	60
Dewpoint	°C	--->	-3.0	0.0	2.5	4.7	6.6	9.9	12.7
	°F	--->	26.6	32.0	36.6	40.5	44.0	49.9	54.8
$T_{outdoors}$	°C	°F							
	10	50	0.00	0.00	0.00	0.00	0.00	0.00	0.24
	5	41	0.00	0.00	0.00	0.00	0.10	0.31	0.48
	0	32	0.00	0.00	0.12	0.23	0.32	0.47	0.60
	-5	23	0.08	0.19	0.29	0.37	0.45	0.57	0.68
	-10	14	0.23	0.32	0.40	0.48	0.54	0.64	0.73
	-15	5	0.33	0.42	0.49	0.55	0.60	0.69	0.77
	-20	-4	0.41	0.49	0.55	0.60	0.65	0.73	0.80
	-25	-13	0.48	0.54	0.60	0.65	0.69	0.76	0.82
	-30	-22	0.53	0.59	0.64	0.68	0.72	0.78	0.84

Above values exclude exterior cladding. Adding cladding will decrease percentages.

Minnesota Residential Energy Code
Overall UA Calculations
12-Sep-23 Rev 1-Oct -2023
John G. Smith, P.E.

Code Components Requirements (Simplified):

Zone 6

	U Factor
Walls:	0.045
Fenestration:	0.30

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R10- CI
Wall framing is 2 x 6 for R=6.88 + R10 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	19.13	32.25
U:	0.052	0.031

Wall Overall U_o: 0.036

Fenestration: U = 0.30

www.ASHRAE-meteo.info

Weather data:	Dec	Jan	Feb	Avg	Coldest Mo.	Avg-10	ASHRAE 99%	99%+15F	Mean Extreme
MSP	21.8	15.9	20.2	19.3	20.2	9.3	-21.1	-6.1	-16.8
Duluth	16.9	10.8	14.9	14.2	14.9	4.2	-24.5	-9.5	-23.3

Allowable to use average winter temperature for the outdoor air temperature for condensation evaluation (per Building Science Corp)

Temperature - outside surface of component

	Framing	Cavity	
Indoor Temp	72.0	72.0	72F/30% RH is 38.9F dewpoint
	68.7	70.1	72F/20% RH is 29.2F dewpoint
	66.6	68.8	-20F/80% RH is -23.9F dewpoint
	66.6	11.7	Need vapor retarder
	33.5	11.7	
	29.7	9.5	
	-18.4	-19.1	
	-19.2	-19.5	
Outdoor Temp -20	-20.0	-20.0	

Ratio Exterior-Interior: 0.50
Ratio Ext-Int w/siding: 0.51

Compare overall U based on percentage of glass
Glass and wall U comply with Table 402.1.2 requirements

% Glass	% Framing	% Cavity	Overall Uo
15.00%	21.25%	63.75%	0.076
20.00%	20.00%	60.00%	0.089
25.00%	18.75%	56.25%	0.102
30.00%	17.50%	52.50%	0.115
35.00%	16.25%	48.75%	0.129
40.00%	15.00%	45.00%	0.142
45.00%	13.75%	41.25%	0.155
50.00%	12.50%	37.50%	0.168

1994 Minnesota Energy Code required an overall Uo of 0.110 for walls, 0.026 for roofs/ceilings and 0.04 for floors
Allowing designed building to meet UA overall based on components that comply with table 402.1.2 requirements will increase the overall Uo as the percent of fenestration increases which is not a desired condition.

From BSD-163: Controlling Cold-Weather Condensation Using Insulation

Table 1: Ratio of exterior-interior insulation to control air leakage condensation

Indoor	RH	--->	20	25	30	35	40	50	60
Dewpoint	°C	--->	-3.0	0.0	2.5	4.7	6.6	9.9	12.7
	°F	--->	26.6	32.0	36.6	40.5	44.0	49.9	54.8
$T_{outdoors}$	°C	°F							
	10	50	0.00	0.00	0.00	0.00	0.00	0.00	0.24
	5	41	0.00	0.00	0.00	0.00	0.10	0.31	0.48
	0	32	0.00	0.00	0.12	0.23	0.32	0.47	0.60
	-5	23	0.08	0.19	0.29	0.37	0.45	0.57	0.68
	-10	14	0.23	0.32	0.40	0.48	0.54	0.64	0.73
	-15	5	0.33	0.42	0.49	0.55	0.60	0.69	0.77
	-20	-4	0.41	0.49	0.55	0.60	0.65	0.73	0.80
	-25	-13	0.48	0.54	0.60	0.65	0.69	0.76	0.82
	-30	-22	0.53	0.59	0.64	0.68	0.72	0.78	0.84

Above values exclude exterior cladding. Adding cladding will decrease percentages.

Equivalent Wall Constructions allowed by IECC

www.ASHRAE-meteo.info

Weather data:	Dec	Jan	Feb	Avg	Coldest Mo.	Avg-10	ASHRAE 99%	99%+15F	Mean Extreme
MSP	21.8	15.9	20.2	19.3	15.9	9.3	-6	9	-16.8
Duluth	16.9	10.8	14.9	14.2	10.8	4.2	-12.1	2.9	-23.3

Allowable to use average winter temperature for the outdoor air temperature for condensation evaluation (per Building Science Corp)

Assume wall is 75% cavity and 25% framing
Wall cavity is R30
Wall framing is 2 x 8 for R=9.06

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	30.00
2 x 8 Framing:	9.06	0.00
Sheathing:	0.79	0.79
CI Rigid:	0.00	0.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	11.31	32.25
U:	0.088	0.031

Wall Overall U_o: 0.045

Ratio Exterior-Interior Insul 0.00
Ratio Ext-Int Insul w/siding: 0.01

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R5 CI
Wall framing is 2 x 6 for R=6.88 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	5.00	5.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	14.12	27.25
U:	0.071	0.037

Wall Overall U_o: 0.045

Ratio Exterior-Interior Insul 0.25
Ratio Ext-Int Insul w/siding: 0.26

Assume wall is 75% cavity and 25% framing
Wall cavity is R13 plus R10 CI
Wall framing is 2 x 4 for R=4.38 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	13.00
2 x 4 Framing:	4.38	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	16.63	25.25
U:	0.060	0.040

Wall Overall U_o: 0.045

Ratio Exterior-Interior Insul 0.77
Ratio Ext-Int Insul w/siding: 0.78

Assume wall is 75% cavity and 25% framing
Wall cavity is R0 plus R20 CI
Wall framing is 2 x 4 for R=4.38 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	0.00
2 x 4 Framing:	4.38	0.00
Sheathing:	0.79	0.79
CI Rigid:	20.00	20.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	26.63	22.25
U:	0.038	0.045

Wall Overall U_o: 0.043

Ratio Exterior-Interior Insul #DIV/0!
Ratio Ext-Int Insul w/siding: #DIV/0!

Proposed for Zone 6 in RE-6
Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R10 CI
Wall framing is 2 x 6 for R=6.88 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R_{total}:	19.12	32.25
U:	0.052	0.031

Wall Overall U_o: 0.036 NOT EQUIVALENT

Ratio Exterior-Interior Insul 0.50
Ratio Ext-Int Insul w/siding: 0.51

Indoor Temp 72.0
Outdoor Temp -20

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	66.5	70.1
1/2" sheetrock:	62.8	68.8
Batt insulation:	62.8	-16.8
2 x 6 Framing:	-10.9	-16.8
Sheathing:	-17.3	-19.1
CI Rigid:	-17.3	-19.1
Siding:	-18.6	-19.5
Outdoor airfilm:	-20.0	-20.0

	Framing	Cavity
Indoor airfilm:	67.6	69.7
1/2" sheetrock:	64.6	68.2
Batt insulation:	64.6	0.7
2 x 6 Framing:	19.8	0.7
Sheathing:	14.7	-2.0
CI Rigid:	-17.9	-18.9
Siding:	-18.9	-19.4
Outdoor airfilm:	-20.0	-20.0

	Framing	Cavity
Indoor airfilm:	68.2	69.5
1/2" sheetrock:	65.7	67.9
Batt insulation:	65.7	20.5
2 x 4 Framing:	41.5	20.5
Sheathing:	37.1	17.6
CI Rigid:	-18.2	-18.8
Siding:	-19.1	-19.4
Outdoor airfilm:	-20.0	-20.0

	Framing	Cavity
Indoor airfilm:	69.7	69.2
1/2" sheetrock:	68.1	67.3
Batt insulation:	68.1	67.3
2 x 4 Framing:	53.0	67.3
Sheathing:	50.2	64.1
CI Rigid:	-18.9	-18.6
Siding:	-19.4	-19.3
Outdoor airfilm:	-20.0	-20.0

	Framing	Cavity
Indoor airfilm:	68.7	70.1
1/2" sheetrock:	66.6	68.8
Batt insulation:	66.6	11.7
2 x 4 Framing:	33.5	11.7
Sheathing:	29.7	9.5
CI Rigid:	-18.4	-19.1
Siding:	-19.2	-19.5
Outdoor airfilm:	-20.0	-20.0